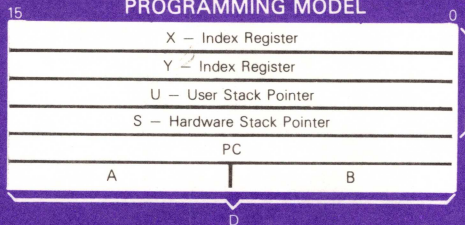
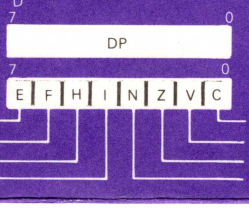
MC6809 — MC6809E

8-bit microprocessor

Reference Card

PROGRAMMING MODEL





MOTOROLA INC.
MOS Integrated Circuits Division
3501 ED BLUESTEIN BLVD. AUSTIN, TEXAS 78721

M6809(AC3)

OP	MNEM	MODE	~	#
00	NEG	DIRECT	6	2
03	COM		6	2
04	LSR		6	2
06	ROR		6	2
07	ASR		6	2
08	ASL/LSL		6	2
09	ROL		6	2
0A	DEC		6	2
0C	INC		6	2
0D	TST		6	2
0E	JMP		3	2
0F	CLR	DIRECT	6	2
12	NOP	INHERENT	2	1
13	SYNC	INHERENT	4	1
16	LBRA	RELATIVE	5	3
17	LBSR	RELATIVE	9	3
19	DAA	INHERENT	2	1
1A	ORCC	IMMED	3	2
1C	ANDCC	IMMED	3	2
1D	SEX	INHERENT	2	1
1E	EXG	IMMED	8	2
1F	TFR	IMMED	6	2
20	BRA	RELATIVE	3	2
21	BRN		3	2
22	BHI		3	2
23	BLS		3	2
24	BHS/BCC		3	2
25	BLO/BCS		3	2
26	BNE		3	2
27	BEQ		3	2
28	BVC		3	2
29	BVS		3	2
2A	BPL		3	2
2B	BMI		3	2
2C	BGE		3	2
2D	BLT	RELATIVE	3	2
2E	BGT	RELATIVE	3	2
2F	BLE	RELATIVE	3	2
30	LEAX	INDEXED	4	2
31	LEAY		4	2
32	LEAS		4	2
33	LEAU	INDEXED	4	2
34	PSHS	IMMED	5	2
35	PULS		5	2
36	PSHU		5	2
37	PULU	IMMED	5	2
39	RTS	INHERENT	5	1
3A	ABX		3	1
3B	RTI	INHERENT	6/15	1
3C	CWAI	IMMED	20	2
3D	MUL	INHERENT	11	1
3F	SWI		19	1
40	NEGA		2	1
43	COMA	INHERENT	2	1

OP	MNEM	MODE	~	#
44	LSRA	INHERENT	2	1
46	RORA		2	1
47	ASRA		2	1
48	ASLA/LSLA		2	1
49	ROLA		2	1
4A	DECA		2	1
4C	INCA		2	1
4D	TSTA		2	1
4F	CLRA		2	1
50	NEGB		2	1
53	COMB		2	1
54	LSRB		2	1
56	RORB		2	1
57	ASRB		2	1
58	ASLB/LSLB		2	1
59	ROLB		2	1
5A	DECB		2	1
5C	INCB	INHERENT	2	1
5D	TSTB	INHERENT	2	1
5F	CLRB	INHERENT	2	1
60	NEG	INDEXED	6	2
63	COM		6	2
64	LSR		6	2
66	ROR		6	2
67	ASR		6	2
68	ASL/LSL		6	2
69	ROL		6	2
6A	DEC		6	2
6C	INC		6	2
6D	TST		6	2
6E	JMP		3	2
6F	CLR	INDEXED	6	2
70	NEG	EXTENDED	7	3
73	COM		7	3
74	LSR		7	3
76	ROR	EXTENDED	7	3
77	ASR	EXTENDED	7	3
78	ASL/LSL		7	3
79	ROL		7	3
7A	DEC		7	3
7C	INC		7	3
7D	TST		7	3
7E	JMP		4	3
7F	CLR	EXTENDED	7	3
80	SUBA	IMMED	2	2
81	CMPA		2	2
82	SBCA		2	2
83	SUBD		4	3
84	ANDA		2	2
85	BITA		2	2
86	LDA		2	2
88	EORA		2	2
89	ADCA		2	2
8A	ORA	IMMED	2	2

OP	MNEM	MODE	~	#
8B	ADDA	IMMED	2	2
8C	CMPX	IMMED	4	3
8D	BSR	RELATIVE	7	2
8E	LDX	IMMED	3	3
90	SUBA	DIRECT	4	2
91	CMPA		4	2
92	SBCA		4	2
93	SUBD		6	2
94	ANDA		4	2
95	BITA		4	2
96	LDA		4	2
97	STA		4	2
98	EORA		4	2
99	ADCA		4	2
9A	ORA		4	2
9B	ADDA		4	2
9C	CMPX		6	2
9D	JSR	DIRECT	7	2
9E	LDX	DIRECT	5	2
9F	STX	DIRECT	5	2
A0	SUBA	INDEXED	4	2
A1	CMPA		4	2
A2	SBCA		4	2
A3	SUBD		6	2
A4	ANDA		4	2
A5	BITA		4	2
A6	LDA		4	2
A7	STA		4	2
A8	EORA		4	2
A9	ADCA		4	2
AA	ORA		4	2
AB	ADDA		4	2
AC	CMPX		6	2
AD	JSR		7	2
AE	LDX		5	2
AF	STX	INDEXED	5	2
B0	SUBA	EXTENDED	5	3
B1	CMPA		5	3
B2	SBCA		5	3
B3	SUBD		7	3
B4	ANDA		5	3
B5	BITA		5	3
B6	LDA		5	3
B7	STA		5	3
B8	EORA		5	3
B9	ADCA		5	3
BA	ORA		5	3
BB	ADDA		5	3
BC	CMPX		7	3
BD	JSR		8	3
BE	LDX		6	3
BF	STX	EXTENDED	6	3
C0	SUBB	IMMED	2	2
C1	CMPB	IMMED	2	2

OP	MNEM	MODE	~	#
C2	SBCB	IMMED	2	2
C3	ADDD		4	3
C4	ANDB		2	2
C5	BITB		2	2
C6	LDB		2	2
C8	EORB		2	2
C9	ADCB		2	2
CA	ORB		2	2
CB	ADDB		2	2
CC	LDD		3	3
CE	LDU	IMMED	3	3
D0	SUBB	DIRECT	4	2
D1	CMPB		4	2
D2	SBCB		4	2
D3	ADDD		6	2
D4	ANDB		4	2
D5	BITB		4	2
D6	LDB	DIRECT	4	2
D7	STB	DIRECT	4	2
D8	EORB		4	2
D9	ADCB		4	2
DA	ORB		4	2
DB	ADDB		4	2
DC	LDD		5	2
DD	STD		5	2
DE	LDU		5	2
DF	STU	DIRECT	5	2
E0	SUBB	INDEXED	4	2
E1	CMPB		4	2
E2	SBCB		4	2
E3	ADDD		6	2
E4	ANDB		4	2
E5	BITB		4	2
E6	LDB		4	2
E7	STB		4	2
E8	EORB	INDEXED	4	2
E9	ADCB	INDEXED	4	2
EA	ORB		4	2
EB	ADDB		4	2
EC	LDD		5	2
ED	STD		5	2
EE	LDU		5	2
EF	STU	INDEXED	5	2
F0	SUBB	EXTENDED	5	3
F1	CMPB		5	3
F2	SBCB		5	3
F3	ADDD		7	3
F4	ANDB		5	3
F5	BITB		5	3
F6	LDB		5	3
F7	STB		5	3
F8	EORB		5	3
F9	ADCB		5	3
FA	ORB	EXTENDED	5	3
FB	ADDB	EXTENDED	5	3
FC	LDD		6	3
FD	STD		6	3
FE	LDU		6	3
FF	STU	EXTENDED	6	3
1021	LBRN	RELATIVE	5	4
1022	LBHI		5(6)	4
1023	LBLS		5(6)	4
1024	LBHS/LBCC		5(6)	4
1025	LBCS/LBLO		5(6)	4
1026	LBNE		5(6)	4
1027	LBEQ		5(6)	4
1028	LBVC		5(6)	4
1029	LBVS		5(6)	4
102A	LBPL		5(6)	4
102B	LBMI		5(6)	4
102C	LBGE		5(6)	4
102D	LBLT	RELATIVE	5(6)	4
102E	LBGT	RELATIVE	5(6)	4
102F	LBLE	RELATIVE	5(6)	4
103F	SWI2	INHERENT	20	2
1083	CMPD	IMMED	5	4
108C	CMPY		5	4
108E	LDY	IMMED	4	4
1093	CMPD	DIRECT	7	3
109C	CMPY		7	3
109E	LDY		6	3
109F	STY	DIRECT	6	3
10A3	CMPD	INDEXED	7	3
10AC	CMPY		7	3
10AE	LDY		6	3
10AF	STY	INDEXED	6	3
10B3	CMPD	EXTENDED	8	4
10BC	CMPY		8	4
10BE	LDY		7	4
10BF	STY	EXTENDED	7	4
10CE	LDS	IMMED	4	4
10DE	LDS	DIRECT	6	3
10DF	STS	DIRECT	6	3
10EE	LDS	INDEXED	6	3
10EF	STS	INDEXED	6	3
10FE	LDS	EXTENDED	7	4
10FF	STS	EXTENDED	7	4
113F	SWI3	INHERENT	20	2
1183	CMPU	IMMED	5	4
118C	CMPS	IMMED	5	4
1193	CMPU	DIRECT	7	3
119C	CMPS	DIRECT	7	3
11A3	CMPU	INDEXED	7	3
11AC	CMPS	INDEXED	7	3
11B3	CMPU	EXTENDED	8	4
11BC	CMPS	EXTENDED	8	4

STACKING ORDER

Pull Order ↓

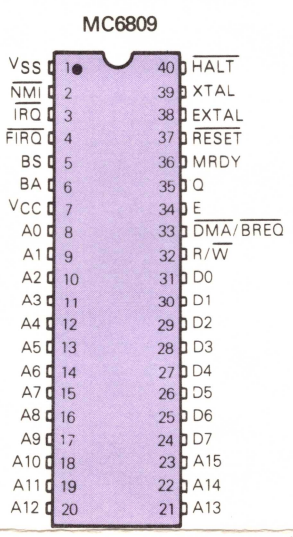
CC
A
B
DP
X Hi
X Lo
Y Hi
Y Lo
U/S Hi
U/S Lo
PC Hi
PC Lo

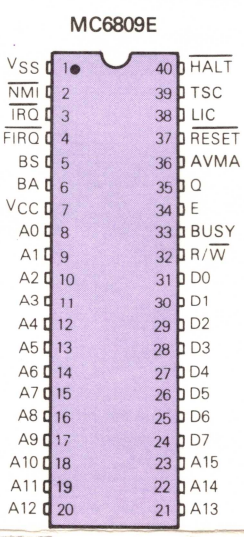
↑ Push Order

Increasing Memory ↓

INTERRUPT VECTORS

FFFE	Restart
FFFC	$\overline{NMI}$
FFFA	SWI
FFF8	$\overline{IRQ}$
FFF6	$\overline{FIRQ}$
FFF4	SWI2
FFF2	SWI3
FFF0	Reserved





HEXADECIMAL AND DECIMAL CONVERSION

HOW TO USE THE TABLES

CONVERSION TO DECIMAL. Find the decimal weights for corresponding hexadecimal characters beginning with the least significant character. The sum of the decimal weight is the decimal value of the hexadecimal number.

CONVERSION TO HEXADECIMAL. Find the highest decimal value in the table which is lower than or equal to the decimal number to be converted. The corresponding hexadecimal character is the most significant character. Subtract the decimal value found from the decimal number to be converted. With the difference, repeat the process to find subsequent hexadecimal characters.

HEXADECIMAL AND DECIMAL CONVERSION

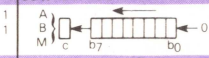
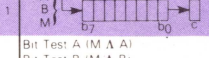
15 BYTE 8				7 BYTE 0			
15 CHAR 12		11 CHAR 8		7 CHAR 4		3 CHAR 0	
HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC
0	0	0	0	0	0	0	0
1	4 096	1	256	1	16	1	1
2	8 192	2	512	2	32	2	2
3	12 288	3	768	3	48	3	3
4	16 384	4	1 024	4	64	4	4
5	20 480	5	1 280	5	80	5	5
6	24 576	6	1 536	6	96	6	6
7	28 672	7	1 792	7	112	7	7
8	32 768	8	2 048	8	128	8	8
9	36 864	9	2 304	9	144	9	9
A	40 960	A	2 560	A	160	A	10
B	45 056	B	2 816	B	176	B	11
C	49 152	C	3 072	C	192	C	12
D	53 248	D	3 328	D	208	D	13
E	57 344	E	3 584	E	224	E	14
F	61 440	F	3 840	F	240	F	15

ASCII CHARACTER SET

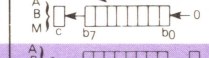
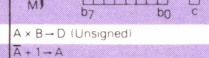
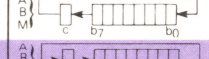
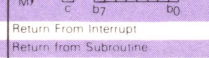
Least Significant Character \ Most Significant Character	0	1	2	3	4	5	6	7
Hex	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P	`	p
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	DEL

POWERS OF TWO

2^n	n	2^n	n	2^n	n
1	0	128	7	16,384	14
2	1	256	8	32,768	15
4	2	512	9	65,536	16
8	3	1,024	10	131,072	17
16	4	2,048	11	262,144	18
32	5	4096	12	524,288	19
64	6	8,192	13	1,048,576	20

Instruction	Forms	Immediate			Direct			Indexed[1]			Extended			Inherent			Description	5 H	3 N	2 Z	1 V	0 C
		Op	~	#	Op	~	#	Op	~	#	Op	~	#	Op	~	#						
ABX														3A	3	1	B + X → X (Unsigned)	•	•	•	•	•
ADC	ADCA	89	2	2	99	4	2	A9	4+	2+	B9	5	3				A + M + C → A	↕	↕	↕	↕	↕
	ADCB	C9	2	2	D9	4	2	E9	4+	2+	F9	5	3				B + M + C → B	↕	↕	↕	↕	↕
ADD	ADDA	8B	2	2	9B	4	2	AB	4+	2+	BB	5	3				A + M → A	↕	↕	↕	↕	↕
	ADDB	CB	2	2	DB	4	2	EB	4+	2+	FB	5	3				B + M → B	↕	↕	↕	↕	↕
	ADDD	C3	4	3	D3	6	2	E3	6+	2+	F3	7	3				D + M:M + 1 → D	•	↕	↕	↕	↕
AND	ANDA	84	2	2	94	4	2	A4	4+	2+	B4	5	3				A ∧ M → A	•	↕	↕	0	•
	ANDB	C4	2	2	D4	4	2	E4	4+	2+	F4	5	3				B ∧ M → B	•	↕	↕	0	•
	ANDCC	1C	3	2													CC ∧ IMM → CC					↕
ASL	ASLA													48	2	1		7	↕	↕	↕	↕
	ASLB													58	2	1		7	↕	↕	↕	↕
	ASL				08	6	2	68	6+	2+	78	7	3					7	↕	↕	↕	↕
ASR	ASRA													47	2	1		7	↕	↕	•	↕
	ASRB													57	2	1		7	↕	↕	•	↕
	ASR				07	6	2	67	6+	2+	77	7	3					7	↕	↕	•	↕
BIT	BITA	85	2	2	95	4	2	A5	4+	2+	B5	5	3				Bit Test A (M ∧ A)	•	↕	↕	0	•
	BITB	C5	2	2	D5	4	2	E5	4+	2+	F5	5	3				Bit Test B (M ∧ B)	•	↕	↕	0	•
CLR	CLRA													4F	2	1	0 → A	•	0	1	0	0
	CLRB													5F	2	1	0 → B	•	0	1	0	0
	CLR				0F	6	2	6F	6+	2+	7F	7	3				0 → M	•	0	1	0	0
CMP	CMPA	81	2	2	91	4	2	A1	4+	2+	B1	5	3				Compare M from A	7	↕	↕	↕	↕
	CMPB	C1	2	2	D1	4	2	E1	4+	2+	F1	5	3				Compare M from B	7	↕	↕	↕	↕
	CMPD	10	5	4	10	7	3	10	7+	3+	10	8	4				Compare M:M + 1 from D	•	↕	↕	↕	↕
		83			93			A3			B3											
	CMPS	11	5	4	11	7	3	11	7+	3+	11	8	4				Compare M:M + 1 from S	•	↕	↕	↕	↕
		8C			9C			AC			BC											
	CMPU	11	5	4	11	7	3	11	7+	3+	11	8	4				Compare M:M + 1 from U	•	↕	↕	↕	↕
		83			93			A3			B3											
	CMPX	8C	4	3	9C	6	2	AC	6+	2+	BC	7	3				Compare M:M + 1 from X	•	↕	↕	↕	↕
	CMPY	10	5	4	10	7	3	10	7+	3+	10	8	4				Compare M:M + 1 from Y	•	↕	↕	↕	↕
		8C			9C			AC			BC											

Instruction	Forms	Immediate			Direct			Indexed[1]			Extended			Inherent			Description	5 H	3 N	2 Z	1 V	0 C
		Op	~	#	Op	~	#	Op	~	#	Op	~	#	Op	~	#						
COM	COMA													43	2	1	$\overline{A} \rightarrow A$	•	↕	↕	0	1
	COMB													53	2	1	$\overline{B} \rightarrow B$	•	↕	↕	0	1
	COM				03	6	2	63	6+	2+	73	7	3				$\overline{M} \rightarrow M$	•	↕	↕	0	1
CWAI		3C	≥20	2													CC ∧ IMM → CC Wait for Interrupt					7
DAA														19	2	1	Decimal Adjust A	•	↕	↕	0	↕
DEC	DECA													4A	2	1	A − 1 → A	•	↕	↕	↕	•
	DECB													5A	2	1	B − 1 → B	•	↕	↕	↕	•
	DEC				0A	6	2	6A	6+	2+	7A	7	3				M − 1 → M	•	↕	↕	↕	•
EOR	EORA	88	2	2	98	4	2	A8	4+	2+	B8	5	3				A ⊻ M → A	•	↕	↕	0	•
	EORB	C8	2	2	D8	4	2	E8	4+	2+	F8	5	3				B ⊻ M → B	•	↕	↕	0	•
EXG	R1, R2	1E	8	2													R1 ↔ R2[2]	•	•	•	•	•
INC	INCA													4C	2	1	A + 1 → A	•	↕	↕	↕	•
	INCB													5C	2	1	B + 1 → B	•	↕	↕	↕	•
	INC				0C	6	2	6C	6+	2+	7C	7	3				M + 1 → M	•	↕	↕	↕	•
JMP					0E	3	2	6E	3+	2+	7E	4	3				EA[3] → PC	•	•	•	•	•
JSR					9D	7	2	AD	7+	2+	BD	8	3				Jump to Subroutine	•	•	•	•	•
LD	LDA	86	2	2	96	4	2	A6	4+	2+	B6	5	3				M → A	•	↕	↕	0	•
	LDB	C6	2	2	D6	4	2	E6	4+	2+	F6	5	3				M → B	•	↕	↕	0	•
	LDD	CC	3	3	DC	5	2	EC	5+	2+	FC	6	3				M:M + 1 → D	•	↕	↕	0	•
	LDS	10	4	4	10	6	3	10	6+	3+	10	7	4				M:M + 1 → S	•	↕	↕	0	•
		CE			DE			EE			FE											
	LDU	CE	3	3	DE	5	2	EE	5+	2+	FE	6	3				M:M + 1 → U	•	↕	↕	0	•
	LDX	8E	3	3	9E	5	2	AE	5+	2+	BE	6	3				M:M + 1 → X	•	↕	↕	0	•
	LDY	10	4	4	10	6	3	10	6+	3+	10	7	4				M:M + 1 → Y	•	↕	↕	0	•
		8E			9E			AE			BE											
LEA	LEAS							32	4+	2+							EA[3] → S	•	•	•	•	•
	LEAU							33	4+	2+							EA[3] → U	•	•	•	•	•
	LEAX							30	4+	2+							EA[3] → X	•	•	↕	•	•
	LEAY							31	4+	2+							EA[3] → Y	•	•	↕	•	•

Instruction	Forms	Immediate			Direct			Indexed[1]			Extended			Inherent			Description	5 H	3 N	2 Z	1 V	0 C
		Op	~	#	Op	~	#	Op	~	#	Op	~	#	Op	~	#						
LSL	LSLA													48	2	1		•	↕	↕	↕	↕
	LSLB													58	2	1		•	↕	↕	↕	↕
	LSL				08	6	2	68	6+	2+	78	7	3					•	↕	↕	↕	↕
LSR	LSRA													44	2	1		•	0	↕	•	↕
	LSRB													54	2	1		•	0	↕	•	↕
	LSR				04	6	2	64	6+	2+	74		3					•	0	↕	•	↕
MUL														3D	11	1	A × B → D (Unsigned)	•	•	↕	•	8
NEG	NEGA													40	2	1	$\overline{A} + 1 \rightarrow A$	↕	↕	↕	↕	↕
	NEGB													50	2	1	$\overline{B} + 1 \rightarrow B$	↕	↕	↕	↕	↕
	NEG				00	6	2	60	6+	2+	70	7	3				$\overline{M} + 1 \rightarrow M$	↕	↕	↕	↕	↕
NOP														12	2	1	No Operation	•	•	•	•	•
OR	ORA	8A	2	2	9A	4	2	AA	4+	2+	BA	5	3				A ∨ M → A	•	↕	↕	0	•
	ORB	CA	2	2	DA	4	2	EA	4+	2+	FA	5	3				B ∨ M → B	•	↕	↕	0	•
	ORCC	1A	3	2													CC ∨ IMM → CC				6	
PSH	PSHS	34	5+[4]	2													Push Registers on S Stack	•	•	•	•	•
	PSHU	36	5+[4]	2													Push Registers on U Stack	•	•	•	•	•
PUL	PULS	35	5+[4]	2													Pull Registers from S Stack	•	•	•	•	•
	PULU	37	5+[4]	2													Pull Registers from U Stack	•	•	•	•	•
ROL	ROLA													49	2	1		•	↕	↕	↕	↕
	ROLB													59	2	1		•	↕	↕	↕	↕
	ROL				09	6	2	69	6+	2+	79	7	3					•	↕	↕	↕	↕
ROR	RORA													46	2	1		•	↕	↕	•	↕
	RORB													56	2	1		•	↕	↕	•	↕
	ROR				06	6	2	66	6+	2+	76	7	3					•	↕	↕	•	↕
RTI														3B	6/15	1	Return From Interrupt					6
RTS														39	5	1	Return from Subroutine	•	•	•	•	•
SBC	SBCA	82	2	2	92	4	2	A2	4+	2+	B2	5	3				A − M − C → A	8	↕	↕	↕	↕
	SBCB	C2	2	2	D2	4	2	E2	4+	2+	F2	5	3				B − M − C → B	8	↕	↕	↕	↕
SEX														1D	2	1	Sign Extend B into A	•	↕	↕	0	•

Instruction	Forms	Immediate			Direct			Indexed[1]			Extended			Inherent			Description	5 H	3 N	2 Z	1 V	0 C
		Op	~	#	Op	~	#	Op	~	#	Op	~	#	Op	~	#						
ST	STA				97	4	2	A7	4+	2+	B7	5	3				A → M	•	↕	↕	0	•
	STB				D7	4	2	E7	4+	2+	F7	5	3				B → M	•	↕	↕	0	•
	STD				DD	5	2	ED	5+	2+	FD	6	3				D → M:M + 1	•	↕	↕	0	•
	STS				10	6	3	10	6+	3+	10	7	4				S → M:M + 1	•	↕	↕	0	•
					DF			EF			FF											
	STU				DF	5	2	EF	5+	2+	FF	6	3				U → M:M + 1	•	↕	↕	0	•
	STX				9F	5	2	AF	5+	2+	BF	6	3				X → M:M + 1	•	↕	↕	0	•
	STY				10	6	3	10			10	7	4				Y → M:M + 1	•	↕	↕	0	•
					9F			AF	6+	3+	BF											
SUB	SUBA	80	2	2	90	4	2	A0	4+	2+	B0	5	3				A − M → A	↕	↕	↕	↕	↕
	SUBB	C0	2	2	D0	4	2	E0	4+	2+	F0	5	3				B − M → B	↕	↕	↕	↕	↕
	SUBD	83	4	3	93	6	2	A3	6+	2+	B3	7	3				D − M:M + 1 → D	•	↕	↕	↕	↕
SWI	SWI[5]													3F	19	1	Software Interrupt 1	•	•	•	•	•
	SWI2[5]													10 3F	20	2	Software Interrupt 2	•	•	•	•	•
	SWI3[5]													11 3F	20	1	Software Interrupt 3	•	•	•	•	•
SYNC														13	≥4	1	Synchronize to Interrupt	•	•	•	•	•
TFR	R1, R2	1F	6	2													R1 → R2[2]	•	•	•	•	•
TST	TSTA													4D	2	1	Test A	•	↕	↕	0	•
	TSTB													5D	2	1	Test B	•	↕	↕	0	•
	TST				0D	6	2	6D	6+	2+	7D	7	3				Test M	•	↕	↕	0	•

Legend:

OP Operation Code (Hexadecimal)
~ Number of MPU Cycles
# Number of Program Bytes
+ Arithmetic Plus

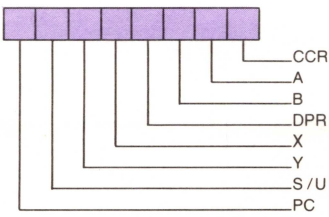
$\overline{M}$ Complement of M
→ Transfer Into
H Half-carry (from bit 3)
N Negative (sign bit)
Z Zero Result

↕ Test and set if true, cleared otherwise
• Not Affected
CC Condition Code Register
: Concatenation
V Logical or

Notes:

1. This column gives a base cycle and byte count. To obtain total count, add the values obtained from the INDEXED ADDRESSING MODES table.
2. R1 and R2 may be any pair of 8 bit or any pair of 16 bit registers.
   The 8 bit registers are: A, B, CC, DP
   The 16 bit registers are: X, Y, U, S, D, PC
3. EA is the effective address.
4. The PSH and PUL instructions require 5 cycles plus 1 cycle for each **byte** pushed or pulled.
5. SWI sets I and F bits. SWI2 and SWI3 do not affect I and F.
6. Conditions Codes set as a direct result of the instruction.
7. Value of half-carry flag is undefined.
8. Special Case – Carry set if b7 is SET.

PUSH/PULL POST BYTE



TRANSFER/EXCHANGE POST BYTE

REGISTER FIELD (Source or Destination)

0000 = D (A:B)	0101 = PC
0001 = X	1000 = A
0010 = Y	1001 = B
0011 = U	1010 = CCR
0100 = S	1011 = DPR

INDEXED ADDRESSING MODES

Type	Forms	Non Indirect		~	#	Indirect		~	#
		Assembler Form	Postbyte OP Code			Assembler Form	Postbyte OP Code		
Constant Offset From R (twos complement offset)	No Offset	,R	1RR00100	0	0	[,R]	1RR10100	3	0
	5 Bit Offset	n, R	0RRnnnnn	1	0	defaults to 8-bit			
	8 Bit Offset	n, R	1RR01000	1	1	[n, R]	1RR11000	4	1
	16 Bit Offset	n, R	1RR01001	4	2	[n, R]	1RR11001	7	2
Accumulator Offset From R (twos complement offset)	A — Register Offset	A, R	1RR00110	1	0	[A, R]	1RR10110	4	0
	B — Register Offset	B, R	1RR00101	1	0	[B, R]	1RR10101	4	0
	D — Register Offset	D, R	1RR01011	4	0	[D, R]	1RR11011	7	0
Auto Increment/Decrement R	Increment By 1	,R+	1RR00000	2	0	not allowed			
	Increment By 2	,R++	1RR00001	3	0	[,R++]	1RR10001	6	0
	Decrement By 1	,-R	1RR00010	2	0	not allowed			
	Decrement By 2	,--R	1RR00011	3	0	[,--R]	1RR10011	6	0
Constant Offset From PC (twos complement offset)	8 Bit Offset	n, PCR	1XX01100	1	1	[n, PCR]	1XX11100	4	1
	16 Bit Offset	n, PCR	1XX01101	5	2	[n, PCR]	1XX11101	8	2
Extended Indirect	16 Bit Address	—	—	—	--	[n]	10011111	5	2

R = X, Y, U or S X = 00 Y = 01
X = Don't Care U = 10 S = 11

~ and # Indicate the number of additional cycles and bytes for the particular variation.

BRANCH INSTRUCTIONS

Instruction	Forms	Addressing Mode Relative OP	~	#	Description	5 H	3 N	2 Z	1 V	0 C
BCC	BCC	24	3	2	Branch C = 0	•	•	•	•	•
	LBCC	10 5(6) 24		4	Long Branch C = 0	•	•	•	•	•
BCS	BCS	25	3	2	Branch C = 1	•	•	•	•	•
	LBCS	10 5(6) 25		4	Long Branch C = 1	•	•	•	•	•
BEQ	BEQ	27	3	2	Branch Z = 1	•	•	•	•	•
	LBEQ	10 5(6) 27		4	Long Branch Z = 1	•	•	•	•	•
BGE	BGE	2C	3	2	Branch ≥ Zero	•	•	•	•	•
	LBGE	10 5(6) 2C		4	Long Branch ≥ Zero	•	•	•	•	•
BGT	BGT	2E	3	2	Branch > Zero	•	•	•	•	•
	LBGT	10 5(6) 2E		4	Long Branch > Zero	•	•	•	•	•
BHI	BHI	22	3	2	Branch Higher	•	•	•	•	•
	LBHI	10 5(6) 22		4	Long Branch Higher	•	•	•	•	•
BHS	BHS	24	3	2	Branch Higher or Same	•	•	•	•	•
	LBHS	10 5(6) 24		4	Long Branch Higher or Same	•	•	•	•	•
BLE	BLE	2F	3	2	Branch ≤ Zero	•	•	•	•	•
	LBLE	10 5(6) 2F		4	Long Branch ≤ Zero	•	•	•	•	•
BLO	BLO	25	3	2	Branch lower	•	•	•	•	•
	LBLO	10 5(6) 25		4	Long Branch Lower	•	•	•	•	•

Instruction	Forms	Addressing Mode Relative OP	~	#	Description	5 H	3 N	2 Z	1 V	0 C
BLS	BLS	23	3	2	Branch Lower or Same	•	•	•	•	•
	LBLS	10 5(6) 23		4	Long Branch Lower or Same	•	•	•	•	•
BLT	BLT	2D	3	2	Branch < Zero	•	•	•	•	•
	LBLT	10 5(6) 2D		4	Long Branch < Zero	•	•	•	•	•
BMI	BMI	2B	3	2	Branch Minus	•	•	•	•	•
	LBMI	10 5(6) 2B		4	Long Branch Minus	•	•	•	•	•
BNE	BNE	26	3	2	Branch Z = 0	•	•	•	•	•
	LBNE	10 5(6) 26		4	Long Branch Z = 0	•	•	•	•	•
BPL	BPL	2A	2	2	Branch Plus	•	•	•	•	•
	LBPL	10 5(6) 2A		4	Long Branch Plus	•	•	•	•	•
BRA	BRA	20	3	2	Branch Always	•	•	•	•	•
	LBRA	16 5		3	Long Branch Always	•	•	•	•	•
BRN	BRN	21	3	2	Branch Never	•	•	•	•	•
	LBRN	10 5 21		4	Long Branch Never	•	•	•	•	•
BSR	BSR	8D	7	2	Branch to Subroutine	•	•	•	•	•
	LBSR	17	9	3	Long Branch to Subroutine	•	•	•	•	•
BVC	BVC	28	3	2	Branch V = 0	•	•	•	•	•
	LBVC	10 5(6) 28		4	Long Branch V = 0	•	•	•	•	•
BVS	BVS	29	3	2	Branch V = 1	•	•	•	•	•
	LBVS	10 5(6) 29		4	Long Branch V = 1	•	•	•	•	•

SIMPLE BRANCHES

	OP	~	#
BRA	20	3	2
LBRA	16	5	3
BRN	21	3	2
LBRN	1021	5	4
BSR	8D	7	2
LBSR	17	9	3

SIMPLE CONDITIONAL BRANCHES (NOTES 1-4)

Test	True	OP	False	OP
N = 1	BMI	2B	BPL	2A
Z = 1	BEQ	27	BNE	26
V = 1	BVS	29	BVC	28
C = 1	BCS	25	BCC	24

SIGNED CONDITIONAL BRANCHES (NOTES 1-4)

Test	True	OP	False	OP
r > m	BGT	2E	BLE	2F
r ≥ m	BGE	2C	BLT	2D
r = m	BEQ	27	BNE	26
r ≤ m	BLE	2F	BGT	2E
r < m	BLT	2D	BGE	2C

UNSIGNED CONDITIONAL BRANCHES (NOTES 1-4)

Test	True	OP	False	OP
r > m	BHI	22	BLS	23
r ≥ m	BHS	24	BLO	25
r = m	BEQ	27	BNE	26
r ≤ m	BLS	23	BHI	22
r < m	BLO	25	BHS	24

Notes:

1. All conditional branches have both short and long variations.
2. All short branches are 2 bytes and require 3 cycles.
3. All conditional long branches are formed by prefixing the short branch opcode with $10 and using a 16-bit destination offset.
4. All conditional long branches require 4 bytes and 6 cycles if the branch is taken or 5 cycles if the branch is not taken.